Increasing Unit Area Productivity and Net Income By Intercropping Peas With Some Wheat Cultivars Under Different Levels Of Nitrogen Fertilizer

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ABSTRACT: A field experiment was carried out during 2018/2019 and 2019/2020 on Sakha Agricultural Research Station Farm, Agricultural Research Center, Egypt, .this study aimed to investigate the effect of nitrogen fertilizer levels (75, 60 and 45kg N/fed) on the productivity of some wheat cultivars (Gemmiza-11, Giza-171 and Misr-1) intercropped with peas (100% wheat + 50% peas as a pure stand) as well as competitive relationships and net return. The experiment was carried out in a split-plot design with three replications. The main-plots were assigned to wheat cultivars, while the sub-plots were apportioned to nitrogen fertilizer levels. The results indicated that Misr-1 cultivar significantly superior other wheat cultivars in yield and its attributes when intercropped with peas, followed by Giza-171 cultivar and then Gemmiza-11cultivar in each season . Intercropping peas with Gemmiza-11 wheat cultivar produced the highest mean values of peas growth, yield and yield attributes, followed by intercropping peas with Giza-171 and then Misr-1 wheat cultivars in each season . Application of 75kg N/fed significantly increased all studied characters of both wheat and peas followed by the application of 60 kg N/fed and then application of 45 kg N/fed in each season . The total green seed of peas did not reach 5% significantly when intercropped with Gemmiza-11and Misr-1 cultivars and 75Kg N/ fed. It can be concluded that the maximum land equivalent ratio (LER), total income and net return were obtained from intercropping wheat with 100 % and peas with 50% of its pure stand and fertilizing Misr-1 cultivar with 75kg N/fed under ecological circumstances of Kafr El-Sheikh Governorate, Egypt.

Keywords: Wheat, peas, intercropping, wheat cultivars, nitrogen fertilizer levels, N-levels, competitive relationships

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important food source for human diet and a part of everyday nutritional needs. It is the high broadly cultivated crop locally with exceptional protein properties that provides produced several kinds of food as bread, macaroni, biscuit and sweets (Abedi *et al.*, 2010). Besides, its straw is good supply of feed for animals. In Egypt, its entire cultivated area touched around 3.500 million fed in 2021 season, and the overall production outstripped 9.000 million tons with an average of 17.87 ardab /fed (FAO, 2021).

Peas (*Pisum sativum* L.) is a family fabaceae as popular vegetable crop. It is abundant in protein and suitable for animal feed and human diet. Other positive effects of pea are the symbiotic nitrogen (N_2) fixation, ability to supply N for agriculture, recycling of N-rich crop residues and the break-crop effect in cereal-rich rotations. The total area grown with green peas in Egypt in the 2019 season was 50577 fed, which produced 175 716 tons with an average yield of 3.474 tons/fed.. At the same time dry peas were166 000 fed with average productive of 0.784 tons /fed (FAO, 2021).

Light, water and nutrients are often used more efficiently when intercropping, which is the simultaneous growth of two or more crop species in the same field, than sole cropping. The improved use of resources results in greater total intercrop yields than sole crops of the same species grown in the same area. This is due to differences in competitive ability for growth factors between intercrop components in time and space (Water er *et al*., 1994).

Choosing the high producing capability cultivars is incredibly valuable to improve productivity of wheat crop for every unit area. El-Met Wally *et al.* (2012) noticed that Sakha 93 and Gemmiza 9 were gave large flag leaf. The Gemmiza 10 gave the highest No. of spikes/m^2. Sakha 93 cultivar gave highest 1000-grain weight. Sakha 94 and Gemmiza 9 gave the greatest grain yield. Atia and Ragab (2013) observed that Gemmeiza 9 cultivar gave the highest grain and straw yields in addition to grain protein and K contents. Gebrel *et al*. (2019) found that fertilized Gemmeiza-11 with 75 kg N fed^{-1}

achieved the highest 1000- grain weight followed by Giza-168 then Shandaweel-1. Gebrel *et al*. (2020) stated that the Misr-2 cultivar recorded the highest height of the plants. Misr-3 cultivar ranked the tallest spikes and grain yield. Bhutto *et al*. (2021) established that the wheat cultivars TD-1 and Moomal-2002 performed better in growth, yield and yield components.

Nitrogen is one of the most important nutrients which diminish the yield of wheat if not utilized in the appropriate quantity as it is necessary for speedy growth of plants and to get superior production. Among many researchers, Kandil *et al.* (2016), Litke *et al.* (2017), Mosanaei *et al.* (2017), Seadh *et al.* (201), Belete *et al.* (2018), Imdad Ullah *et al.* (2018), Liu *et al.* (2019) and Gebrel *et al*. (2020) revealed that due to all biochemical processes occurring in wheat plants governed by N, thus N essential for better growth and increasing yield. Hence, it is essential to utilize suitable nitrogen level that that consider the beneficial aspects for boosting wheat growing and production (Ali *et al.,* 2000).

Wheat-peas intercropping is a cropping strategy that use N– sources efficiently due to its self-regulating spatial dynamics .Peas improve their interspecific competitive ability in areas with lower soil N-levels ; and vice versa for wheat. (Ghaley et *al*., 2005). Sarunaite *et al*. (2013) suggested that the pea/wheat intercropping system was superior to the solo pea or wheat crop. Pankou *et al*. (2021) showed that intercropping wheat with pea increased land equivalent ratio (LER) and yield advantage over mono-crops.

Therefore, this investigation intended to increase unit area productivity and net income by intercropping peas and wheat under the environmental conditions of Kafr El-Sheikh Governorate, Egypt.

MATERIALS AND METHODS

A field experiment was conducted in the two winter growing seasons of 2018/2019 and 2019/2020 on S A R S F , A R C , Egypt, to study the effect of nitrogen fertilizer levels on the productivity of some wheat cultivars intercropped with peas as well as competitive relationships and not return.

The field experiment was conducted in a split-plot layout with 3 repetitions. The main-plots were allocated to the 3 wheat cultivars (Gemmiza-11, Giza-171 and Misr-1) intercropped with peas. The Egyptian wheat cultivars seeds were gained from Wheat Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt.

The sub–plots were apportioned to the three nitrogen fertilizer levels (75, 60 and 45 kg N/fed. The nitrogen fertilizer ammonium nitrate (33.5 % N) was utilized broadcast in double equal dosages before 1st and 2nd irrigations.

Every experimental unit (sub-plot) included four terrace, each of 1.2 m width and 4.0 m length, resulting in 19.2 m^2. The preceding summer crop was maize in each season .

During soil preparation in the two growing seasons, soil samples were randomly taken from soil surface (0 - 30 cm), of the experimental site. Then, particle size distribution and chemical analyses were passed by the method expressed by Page *et al.* (1982), and the results are exposed in Table 1

Table 1. Mechanical and chemical properties of the experimental soils during 2018/2019 and 2019/2020 growing seasons.

Properties		2018/2019 season		2019/2020 season	
		Before sowing	**After sowing**	**Before sowing**	**After sowing**
A: particle size distribution :					
Sand %		9.45	9.45	9.15	9.15
Silt %		29.25	29.25	28.75	28.75
Clay %		61.30	61.30	62.10	62.10
Texture		Clayey	Clayey	Clayey	Clayey
B: Chemical analysis:					
pH		8.05	7.90	7.93	7.63
EC ds/m^2		2.95	2.06	2.90	2.02
Organic matter (g kg^{-1})		10.7	11.30	12.8	13.10
Total N %		0.13	0.14	0.15	0.16
Total carbonate %		6.40	6.14	6.55	6.26
CEC meq/100 g soil		41.00	40.15	40.90	40.17
SP %		78.45	69.00	78.50	79.10
SAR		4.50	3.06	4.60	3.39
Available mg/kg	N	28.00	30.00	29.50	31.00
	P	8.90	9.10	10.05	10.75
	K	240.70	245.00	255.00	265.00
Soluble Cations meq/L	Ca^{++}	6.35	5.50	6.40	5.63
	Mg^{++}	6.45	4.90	6.65	3.92
	Na^{+}	10.50	9.85	9.95	10.48
	K^{+}	0.40	0.35	0.55	0.20
Soluble anions meq/L	CO_3^{--}	0.00	0.00	0.00	0.00
	HCO_3^{-}	4.65	3.95	4.70	3.00
	Cl^{-}	9.50	9.10	8.95	8.16
	SO_4^{--}	11.50	7.55	10.90	9.12

The experimental field was well prepared through two plowings, and then divided into the experimental units (19.2 m^2). Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation (after plowing and before ridging) at the rate of 150 kg/fed.

Wheat was intercropped with peas by using intercropping system (100% seeding rate of wheat +50% seeding rate of peas as a soft crop) . Peas seeds were sown before wheat by about 43 days in hills (3 seeds/hill), by hand sowing, at 10 cm apart on both sides of each terrace on October 13th and 10th in the first and second seasons. However, by hand drilling method . Wheat cultivars were sown on the top of the same terraces in four rows .20 cm apart, on November 24th and 22nd in 1st and 2nd time of year, correspondingly. Peas was planted on both sides of terraces at 50 % plant density, Wheat was planted on the back of terraces in 8 rows at 100 % from plant density in each season .

The solo (swon Wheat only with out intercropping as well as Peas) cultivation of both three studied wheat cultivars and peas was completed as recommendations for each crop. According to the agricultural recommendations .The other agricultural practices for wheat and peas were done Harvesting was done for peas on January 15th and 11th and for wheat on May 20th and 15th in 1st and 2nd time of year, correspondingly.

Recorded data:

1. Wheat characters:

At harvest, 1 m^2 was randomly selected from each of sub-plots to estimate plant height (cm), No. of spikes/m^2, spike length (cm), No. of spikelet /spike, No. of grains/spike, grains weight/spike (g) and 1000-grain weight (g). Grain yield (t/fed) was calculated by whole harvesting plants in each sub-plot and air- dried, then threshed and the grains at 13 % moisture content were weighted in kg and converted to tons per feddan. Straw yield (t/fed), was weighted in kg /plot, then, it was converted to ton per feddan.

2. Peas characters:

At harvest time, samples of 10 plants were randomly taken from each sub-plot to determine the following parameters; plant height (cm), No. of branches/plant, No. of pods/plant, pod length and diameter (cm), No. of seeds/pod, green pod weight (g), 100-seed weight (g) and total green seed yield (t/fed) was calculated as the total weight of green pods (t/fed).

3
. Competitive relationships:
a- **Land equivalent ratio (LER) was determined according to the formula described by Willey and Rao (1980):**

$$LER = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

Yaa and Ybb were a pure stand of the crop, a (Wheat) and b(Peas), respectively. Yab is the mixture yield of a crop, and Yba is the mixture yield b crop.

b- Aggressivity (Ag) was calculated according to Mc-Gilchrist (1965) as the following formula:

- For crop (a),

$$A_{ab} = \frac{Y_{ab}}{Y_{aa}\ x\ Z_{ab}} - \frac{Y_{ba}}{Y_{bb}\ x\ Z_{ba}}$$

- and for the crop (b),

$$A_{ba} = \frac{Y_{ba}}{Y_{bb}\ x\ Z_{ba}} - \frac{Y_{ab}}{Y_{aa}\ x\ Z_{ab}}$$

Where:
Aab = aggressively value for the component a (Wheat).
Aba = Aggressively value for the component (Peas).
Yab is the intercrop yield of maize, Zab is the percentage of the area occupied by **Peas**

c- Relative crowding coefficient (RCC) or K was calculated according to De-Wit (1960) as follows:
K = Kab × Kba

$$Kab = \frac{Yab\ x\ Zba}{(Yaa - Yab)Zab} \qquad Kba = \frac{Yba\ x\ Zab}{(Ybb - Yba)Zba}$$

Where: a is wheat and b is the peas respectively. Zab is the percentage of the area occupied by Wheat, and Zba is the area occupied by Peas.
4. Net return
Gross return from each treatment was calculated in Egyptian pounds (L.E.) according to the Ministry of Agriculture and Lands Reclamation, Economic Affairs Sector, Agricultural Statistics. Where market prices of Wheat grains were 4170 and 4350 L.E./ ton, straw yield were 1800 and 1400 L.E.\ ton peas seed were 5 and 6 L.E./kg in 2019 and 2020seasons, respectively.
Net return = Total income – Total costs
Fed. (L.E.) = Gross return – Total costs .
Statistical analysis:
The data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split-plot design as published by **Gomez and Gomez (1984)** using the "MSTAT-C" software package. In addition, treatment means were compared by using the least significant difference (LSD) method at 5 % level probability as described by **Snedecor and Cochran (1980)**.

RESULTS AND DISCUSSIONS

1- yield and its components of wheat:

Data presented in Tables 2 and 3 revealed that all studied wheat cultivars (Gemmiza-11, Giza-171 and Misr-1) significantly differed in agronomic characters and yield components when intercropped with peas, except the No. of spikelet/spike in each season . Misr-1 cultivar showed significant superior the other wheat cultivars (Gemmiza-11 and Giza-171) in regard to plant height, No. of spikes/m^2, spike length, No. of spikelet/spike, No. of grains/spike, grains weight/spike, 1000-grain weight, grain and straw yields/fed when intercropped with peas, followed by Giza-171 cultivar in each season . At the same time , the lowest values of these treats resulted from the Gemmiza-11 cultivar in each season . These results are mainly due to the differences in their genetical constitution and genetic factors makeup among studied wheat cultivars. These results are in agreement with those detected by **El-Metwally *et al.* (2012), Atia and Ragab (2013), Gebrel *et al.* (2019), Gebrel *et al.* (2020) and Bhutto *et al.* (2021)**.

Table 2: Plant height, No. of spikes/m^2, spike length, No. of spikelets /spike and No. of grains/spike of wheat intercropped with peas as affected by wheat cultivars and nitrogen fertilizer levels as well as their interaction during 2018/2019 and 2019/2020 seasons.

Characters / Treatments		Grains weight/spike (g)		1000-grain weight (g)		Grain yield (t/fed)		Straw yield (t/fed)	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Wheat cultivars:									
Gemmiza-11		2.78	2.91	47.55	51.11	2.787	2.923	3.247	3.097
Giza-171		3.21	3.34	54.11	55.22	2.980	3.105	3.450	3.316
Misr-1		3.40	3.51	55.00	61.88	3.089	3.193	3.537	3.431
LSD at 5 %		0.15	0.18	0.84	0.73	0.89	0.094	0.103	0.102
Nitrogen fertilizer levels:									
75 kg N/fed		3.34	3.46	56.44	61.33	3.167	3.291	3.656	3.523
60 kg N/fed		3.14	3.24	50.66	54.55	2.998	3.118	3.453	3.331
45 kg N/fed		2.91	3.05	49.55	52.33	2.691	2.812	3.124	2.990
LSD at 5 %		0.16	0.17	0.96	0.87	0.073	0.071	0.085	0.082
Interaction:									
	75 kg N/fed	3.03	3.13	53.00	56.33	2.995	3.130	3.478	3.328
Gemmiza-11	60 kg N/fed	2.80	2.90	46.33	49.33	2.762	2.897	3.219	3.069
	45 kg N/fed	2.53	2.70	43.33	47.66	2.603	2.741	3.045	2.893
	75 kg N/fed	3.40	3.53	57.66	62.00	3.152	3.287	3.652	3.519
Giza-171	60 kg N/fed	3.23	3.33	50.33	52.33	3.072	3.192	3.547	3.414
	45 kg N/fed	3.00	3.16	54.33	54.33	2.715	2.835	3.150	3.016
	75 kg N/fed	3.60	3.73	58.66	65.66	3.353	3.456	3.839	3.722
Misr-1	60 kg N/fed	3.40	3.50	55.33	62.00	3.160	3.265	3.594	3.511
	45 kg N/fed	3.20	3.30	51.00	58.00	2.754	2.859	3.177	3.060
LSD at 5 %		0.20	0.22	1.45	1.51	0.127	0.127	0.123	0.147
Solo wheat		3.80	3.85	61.00	6400	3.400	3.500	3.900	3.880

From the results in Tables 2 and 3, the nitrogen fertilizer levels (75, 60 and 45 kg N/fed) showed a significant effect on all studied characters of wheat intercropped with peas. *i.e.* plant height, No. of spikes/m^2, spike length, No. of spikelet/spike, No. of grains/spike, grains weight/spike, 1000-grain weight, grain and straw yields/fed in both growing seasons. Application of 75 kg N/fed significantly increased all studied characters of wheat intercropped with peas and resulted in the highest values in each season . Application of 60 kg N/fed came in the second rank in each season . On the other hand, the application of 45 kg N/fed gave the lowest values of all studied characters of wheat intercropped with peas in each season. These results might be due to the low soil content of available nitrogen (Table 1), since nitrogen is considered one of the mayor elements for plant nutrition .It increases the vegetative growth of plants by encouraging plants to uptake other elements and consequently improving photosynthesis and all yield components. These results are incompatible with hose found by **Seadh *et al.* (2017), Belete *et al.* (2018), Imdad Ullah *et al.* (2018), Liu *et al.* (2019), and Gebrel *et al.* (2020**).

Table 3: Grains weight/spike, 1000-grain weight, grain and straw yields/fed of wheat intercropped with peas as affected by wheat cultivars and nitrogen fertilizer levels as well as their interaction during 2018/2019 and 2019/2020 seasons.

Characters / Treatments		Grains weight/spike (g)		1000-grain weight (g)		Grain yield (t/fed)		Straw yield (t/fed)	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Wheat cultivars:									
Gemmiza-11		2.78	2.91	47.55	51.11	2.787	2.923	3.247	3.097
Giza-171		3.21	3.34	54.11	55.22	2.980	3.105	3.450	3.316
Misr-1		3.40	3.51	55.00	61.88	3.089	3.193	3.537	3.431
LSD at 5 %		0.15	0.18	0.84	0.73	0.89	0.094	0.103	0.102
Nitrogen fertilizer levels:									
75 kg N/fed		3.34	3.46	56.44	61.33	3.167	3.291	3.656	3.523
60 kg N/fed		3.14	3.24	50.66	54.55	2.998	3.118	3.453	3.331
45 kg N/fed		2.91	3.05	49.55	52.33	2.691	2.812	3.124	2.990
LSD at 5 %		0.16	0.17	0.96	0.87	0.073	0.071	0.085	0.082
Interaction:									
Gemmiza-11	75 kg N/fed	3.03	3.13	53.00	56.33	2.995	3.130	3.478	3.328
	60 kg N/fed	2.80	2.90	46.33	49.33	2.762	2.897	3.219	3.069
	45 kg N/fed	2.53	2.70	43.33	47.66	2.603	2.741	3.045	2.893
Giza-171	75 kg N/fed	3.40	3.53	57.66	62.00	3.152	3.287	3.652	3.519
	60 kg N/fed	3.23	3.33	50.33	52.33	3.072	3.192	3.547	3.414
	45 kg N/fed	3.00	3.16	54.33	54.33	2.715	2.835	3.150	3.016
Misr-1	75 kg N/fed	3.60	3.73	58.66	65.66	3.353	3.456	3.839	3.722
	60 kg N/fed	3.40	3.50	55.33	62.00	3.160	3.265	3.594	3.511
	45 kg N/fed	3.20	3.30	51.00	58.00	2.754	2.859	3.177	3.060
LSD at 5 %		0.20	0.22	1.45	1.51	0.127	0.127	0.123	0.147
Solo wheat		3.80	3.85	61.00	6400	3.400	3.500	3.900	3.880

The interaction between wheat cultivars and nitrogen fertilizer levels exhibited a significant effect on plant height, No. of spikes/m2, spike length, No. of grains/spike, grains weight/spike, 1000-grain weight, grain and straw yields/fed of wheat intercropped with peas, except the No. of spikelet/spike in each season (Tables 2 and 3). Data also showed wheat the highest values of plant height, No. of spikes/m2, spike length, No. of grains/spike, grains weight/spike, 1000-grain weight, grain and straw yields/fed were obtained when Misr-1 cultivar received 75 kg N/fed in each season . While, fertilizing Gemmiza-11, a cultivar with 45 kg N/fed recorded the lowest values yield and its attributes when intercropped with peas in each season .

2. charters of Peas:

Studied wheat cultivars (Gemmiza-11, Giza-171 and Misr-1) significantly affected plant height, No. of pods/plants, green pod weight , and total green seed yield/fed of peas intercropped with wheat, in contrast the No. of branches/plant, pod length and diameter, No. of seeds/pod, and 1000-seed weight of peas intercropped with wheat did not significantly differed in each season , as shown in Tables 4 and 5. The achieved data exposed that intercropping peas with Gemmiza-11 wheat cultivars produced the highest values of plant height, No. of branches/plant, No. of pods/plants, pod length and diameter, No. of seeds/pod, green pod weight, 100-seed weight and total green seed yield/fed of peas intercropped with wheat, followed by intercropping peas with Giza-171 wheat cultivar in each season . At the same time , the lowest values of growth, yield and yield attributes of peas intercropped with wheat resulted from intercropping peas with Misr-1 wheat cultivar in each season . These results are mainly due to competition between wheat and peas plants in nutrients, water and light. These results are in harmony with those noticed by **Sarunaite *et al.* (2013)**. In addition, **Pankou *et al.* (2021)** showed that intercropping wheat with pea increased land equivalent ratio (LER) and yield advantage.

Studied nitrogen fertilizer levels (75, 60 and 45 kg N/fed) proved significant effect on plant height, No. of branches/plant, No. of pods/plants, pod length, green pod weight, 1000-seed weight and total green seed yield/fed of peas intercropped with wheat in both growing seasons (Tables 4 and 5), at the same time pod diameter and No. of seeds/pod of peas intercropped with wheat did not affect the studied

Table 4: Plant height, No. of branches/plant, No. of pods/plants, pod length and diameter of peas intercropped with wheat as affected by wheat cultivars and nitrogen fertilizer levels as well as their interaction during 2018/2019 and 2019/2020 seasons.

Characters / Treatments		Plant height (cm)		No. of branches/plant		No. of pods/plants		Pod length (cm)		Pod diameter (cm)	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Wheat cultivars:											
Gemmiza-11		78.44	79.55	3.39	3.48	16.66	20.11	9.55	10.44	1.228	1.216
Giza-171		75.11	77.66	3.14	3.25	14.22	17.22	9.33	10.33	1.210	1.193
Misr-1		72.44	74.33	3.08	3.21	12.88	15.88	9.33	10.11	1.194	1.170
LSD at 5 %		2.84	2.73	NS	NS	0.79	0.80	NS	NS	NS	NS
Nitrogen fertilizer levels:											
75 kg N/fed		77.66	79.11	4.05	4.15	17.44	20.77	10.00	10.55	1.220	1.207
60 kg N/fed		74.66	78.11	3.11	3.25	14.88	18.00	9.22	10.22	1.208	1.192
45 kg N/fed		73.66	74.33	2.45	2.54	11.44	14.44	9.00	10.11	1.204	1.180
LSD at 5 %		1.58	1.62	0.26	0.27	2.04	2.05	0.36	0.33	NS	NS
Interaction:											
Gemmiza-11	75 kg N/fed	80.33	80.66	3.33	3.47	20.33	22.33	10.33	10.66	1.233	1.220
	60 kg N/fed	78.33	81.00	3.01	3.13	18.00	21.33	9.33	10.33	1.227	1.210
	45 kg N/fed	76.66	77.00	2.99	3.16	11.66	14.66	9.00	10.33	1.223	1.217
Giza-171	75 kg N/fed	76.66	79.33	4.14	4.21	16.66	19.66	10.00	10.66	1.233	1.230
	60 kg N/fed	75.00	78.66	4.04	4.15	14.33	17.33	9.00	10.33	1.210	1.193
	45 kg N/fed	73.66	75.00	3.99	4.11	11.66	14.66	9.00	10.00	1.187	1.157
Misr-1	75 kg N/fed	76.00	78.00	2.70	2.73	15.33	18.33	9.66	10.33	1.203	1.170
	60 kg N/fed	72.33	74.00	2.38	2.48	12.33	15.33	9.33	10.00	1.193	1.173
	45 kg N/fed	69.00	71.00	2.27	2.38	11.00	14.00	9.00	10.00	1.187	1.167
LSD at 5 %		3.35	3.47	NS	NS	2.45	2.55	NS	NS	NS	NS
Solo peas		81.00	82.00	4.32	4.41	21.00	23.00	11.00	11.00	1.262	1.230

nitrogen fertilizer levels in each season . Fertilizing with 75 kg N/fed resulted in the highest values of growth, yield and attributes of peas intercropped wheat, followed by fertilizing with 60 kg N/fed in each season . On the other side, fertilizing with 45 kg N/fed gave the lowest values of all studied characters of peas intercropped with wheat in each season . These results might be due to the role of nitrogen as one of the major elements for plant nutrition, and it increases the vegetative cover for plants and forms strong plants. Moreover, nitrogen encourages the plant to uptake other elements. These results are incompatible with those found by **Ghaley *et al*. (2005)**.

The interaction between wheat cultivars and nitrogen fertilizer levels significantly affected plant height, the No. of pods/plants, green pod weight and total green seed yield/fed of peas intercropped with wheat in each season (Tables 4 and 5). The data tabulated in Tables 4 and 5 showed that the highest values of all studied

Table 5: No. of seeds/ pod, green pod weight\ plant, 100-seed weight and total green seed yield/fed of peas intercropped with wheat as affected by wheat cultivars and nitrogen fertilizer levels as well as their interaction during 2018/2019 and 2019/2020 seasons.

Characters / Treatments		No. of seeds/pod		Green pod weight / plant (g)		100-seed weight (g)		Total green seed yield (t/fed)	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Wheat cultivars:									
Gemmiza-11		8.77	9.22	55.68	58.78	21.11	22.77	0.805	1.026
Giza-171		8.22	9.00	49.95	53.05	21.11	22.00	0.802	1.022
Misr-1		8.22	8.88	48.68	51.78	20.77	21.66	0.793	1.013
LSD at 5 %		NS	NS	2.17	2.15	NS	NS	0.011	0.010
Nitrogen fertilizer levels:									
75 kg N/fed		8.55	9.22	57.87	60.97	21.88	22.88	0.886	1.106
60 kg N/fed		8.33	9.11	51.52	54.62	21.11	22.00	0.806	1.026
45 kg N/fed		8.33	8.77	44.92	48.02	20.00	21.55	0.708	0.929
LSD at 5 %		NS	NS	1.30	1.28	0.90	0.88	0.033	0.032
Interaction:									
Gemmiza-11	75 kg N/fed	9.00	9.66	55.01	58.11	22.33	23.00	0.889	1.109
	60 kg N/fed	8.66	9.33	50.43	53.53	21.33	21.66	0.819	1.039
	45 kg N/fed	8.66	8.66	44.43	47.53	19.66	21.33	0.709	0.932
Giza-171	75 kg N/fed	8.33	9.33	53.10	56.20	21.00	22.66	0.887	1.107
	60 kg N/fed	8.33	9.00	49.14	52.24	21.00	22.00	0.808	1.028
	45 kg N/fed	8.00	8.66	43.81	49.63	20.33	21.33	0.708	0.928
Misr-1	75 kg N/fed	8.33	9.00	65.51	68.61	22.33	22.33	0.882	1.102
	60 kg N/fed	8.33	9.00	55.00	58.10	21.00	22.00	0.789	1.009
	45 kg N/fed	8.00	8.66	46.53	46.91	20.00	22.00	0.708	0.928
LSD at 5 %		NS	NS	2.25	2.22	NS	NS	0.042	0.045
Solo peas		9.66	9.66	66.69	69.61	23.00	24.00	1.530	1.663

growth traits, yield and attributes of peas intercropped wheat resulted from fertilizing Gemmiza - 11 cultivar with 75 kg N /fed followed by fertilizing Giza-171 cultivar with 75 kg N/fed in each season . While, fertilizing Misr-1 cultivar with 45 kg N/fed recorded the lowest values of all studied growth traits, yield and peas intercropped wheat attributes in each season .the total green seed yield was insignificant under 75 kg N /fad with Gemmiza 11 and Misr 1 cultivars .

3. Competitive relationships:

(a) Land equivalent ratio:

Data in Table 6 showed that all treatments of the interaction between wheat cultivars and nitrogen fertilizer levels of wheat intercropped with peas raised land productivity compared with the planting of wheat and peas in pure stand in each season . The best treatment included fertilizing Misr-1 cultivar with 75 kg N/fed, where this treatment increases land usage by 56 and 65 % in 1st and 2nd time of year, correspondingly. Simultaneously, the lowest treatment was fertilizing Gemmiza-11 cultivar with 45 kg N/fed. This treatment increased land productivity by 23 and 34% in the first and second seasons. Thus, it is evident that wheat was the better contributor in LER in all treatments in each season .

(b) Aggressivity (A):

Data presented in Table 6 revealed that peas are dominated crop in all treatments in each season due to the interaction between wheat cultivars and nitrogen fertilizer levels A wheat crop had higher competitive abilities compared with peas. Where, wheat was planted by 100 % of its pure stand and peas was intercropped with wheat by 50 % .

(c) Relative Crowding Coefficient (RCC):

Data in Table 6 showed that the interaction between wheat cultivars and nitrogen fertilizer levels achieved yield advantageous in all treatments in each season . The highest yield advantage (97.1 and 154.29) were recorded by fertilizing the Misr-1 cultivar with 75 kg N/fed in 1st and 2nd time of year, correspondingly. On the other hand, the lowest yield advantage (2.82 and 4.60) were shown with the treatment of fertilizing Gemmiza-11 cultivar with 45 kg N/fed in 1st and 2nd time of year, correspondingly.

Table 6: Land equivalent ratio (LER), aggressivity (Ag) and relative crowding coefficient (RCC) of intercropping wheat with peas as affected by the interaction between wheat cultivars and nitrogen fertilizer levels during 2018/2019 and 2019/2020 seasons.

Characters		LER			Ag		RCC			LER			Ag		RCC		
Wheat cultivars	Nitrogen levels	L w	L p	LER	Ag w	Ag p	K w	K p	K	L w	L p	LER	Ag w	Ag p	K w	K p	K
		2018/2019 season								2019/2020 season							
Gemmiza-11	75 kg N/fed	0.88	0.58	1.46	-0.45	0.45	3.64	2.82	10.62	0.89	0.67	1.56	-0.69	0.69	4.17	4.06	16.93
	60 kg N/fed	0.81	0.54	1.35	-0.41	0.41	2.13	2.34	4.99	0.83	0.62	1.45	-0.66	0.66	2.37	3.38	8.00
	45 kg N/fed	0.77	0.46	1.23	-0.26	0.26	1.61	1.75	2.82	0.78	0.56	1.34	-0.53	0.53	1.78	2.54	4.60
Giza-171	75 kg N/fed	0.93	0.58	1.51	-0.37	0.37	6.25	2.8	17.53	0.94	0.67	1.61	-0.52	0.52	7.60	4.04	30.73
	60 kg N/fed	0.90	0.53	1.43	-0.25	0.25	4.61	2.27	10.48	0.91	0.62	1.53	-0.51	0.51	5.10	3.29	16.78
	45 kg N/fed	0.80	0.46	1.26	-0.21	0.21	1.95	1.75	3.41	0.81	0.56	1.37	-0.48	0.48	2.10	2.56	5.38
Misr-1	75 kg N/fed	0.98	0.58	1.56	-0.27	0.27	35.14	2.76	97.1	0.99	0.66	1.65	-0.53	0.53	38.69	3.99	154.29
	60 kg N/fed	0.93	0.52	1.45	-0.18	0.18	6.49	2.16	14.02	0.93	0.67	1.60	-0.63	0.63	6.84	4.06	27.81
	45 kg N/fed	0.81	0.46	1.27	-0.19	0.19	2.1	1.75	3.67	0.82	0.56	1.37	-0.47	0.47	2.20	2.56	5.63

w = wheat, p = peas.

4. Net Return:

Data presented in Table 7 revealed that most treatments of the interaction between wheat cultivars and nitrogen fertilizer levels were exceeded total income and net return compared to cultivation wheat or peas alone in each season . The highest values of total income (25302.2 and 26856.4 LE) and net return (15802.2 and 16706.4 LE) were achieved when fertilizing Misr-1 cultivar with 75 kg N / fed in the first and second seasons, respectively. On the other hand, the lowest values of total income (19880.5 and 21565.6 LE) and net return (10780.5and 11865.6 LE) were obtained when fertilizing the Gemmiza-11 cultivar with 45 kg N/fed in each season.

Table 7: Effect of the interaction between wheat cultivars and nitrogen fertilizer levels on economic evaluation of wheat intercropped with peas during 2018/2019 and 2019/2020 seasons.

Characters		Actual wheat grain yield (t/fed) (LE)	Actual wheat straw yield (t/fed) (LE)	Actual peas green seed yield (t/fed) (LE)	Total income (LE)	Total cost (LE)	Net return (LE)	Actual wheat grain yield (t/fed) (LE)	Actual wheat straw yield (t/fed) (LE)	Actual peas green seed yield (t/fed) (LE)	Total income (LE)	Total cost (LE)	Net return (LE)
Wheat cultivars	Nitrogen levels												
		2018/2019 season						2019/2020 season					
Gemmiza-11	75 kg N/fed	12489.2	6260.4	4445.0	23194.6	9500	13694.6	13615.5	4659.2	6654.0	24928.7	10150	14778.7
	60 kg N/fed	11517.5	5794.2	4095.0	21406.7	9300	12106.7	12601.9	4296.6	6234.0	23132.5	9900	13232.5
	45 kg N/fed	10854.5	5481.0	3545.0	19880.5	9100	10780.5	11923.4	4050.2	5592.0	21565.6	9700	11865.6
Giza-171	75 kg N/fed	13143.8	6573.6	4435.0	24152.4	9500	14652.4	14298.5	4926.6	6642.0	25867.1	10150	15717.1
	60 kg N/fed	12810.2	6384.6	4040.0	23234.8	9300	13934.8	13885.2	4779.6	6168.0	24832.8	9900	14932.8
	45 kg N/fed	11321.5	5670.1	3540.0	20531.6	9100	11431.6	12332.3	4222.4	5568.0	22122.7	9700	12422.7
Misr-1	75 kg N/fed	13982.0	6910.2	4410.0	25302.2	9500	15802.2	15033.6	5210.8	6612.0	26856.4	10150	16706.4
	60 kg N/fed	13177.2	6469.2	3945.0	23591.4	9300	14291.4	14202.8	4915.4	6054.0	25172.2	9900	15272.2
	45 kg N/fed	11484.2	5718.6	3540.0	20742.8	9100	11642.8	12436.7	4284.0	5568.0	22288.7	9700	12588.7
Solo wheat		14178.0	7020.0	-	21198.0	8000	13198	15225.0	5432.0	-	20657.0	8500	12157.0
Solo peas		-	-	7650.0	7650.0	5100.5	2550.0	-	-	9987.0	9978.0	5350.0	4628.0

CONCLUSION.

It could be concluded that the maximum land equivalent ratio (LER), total income and net return were obtained from intercropping wheat (Misr-1 cultivar) with 100 % and peas with 50 % of this pure stand and fertilizing with 75 kg N/fed under the environmental conditions of Kafr El-Sheikh Governorate, Egypt.

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الملخص العربي

زيادة أنتاجية وحدة المساحة والعائد النقدى للمزارع بتحميل البسلة مع بعض أصناف القمح تحت معدلات مختلفة من السماد النتروجينى

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تم تكرار تجربة حقلية خلال موسمى الزراعة الشتوية 2019/2018 و 2020/2019 بمزرعة محطة البحوث الزراعية بسخا، مركز البحوث الزراعية، مصر، لدراسة تأثير مستويات السماد النيتروجينى (75 ، 60 ، 45 كجم نيتروجين / فدان) على إنتاجية بعض أصناف القمح (جميزة 11 ، جيزة 171 ، مصر 1) المحمل مع البسلة وزرع القمح بنسبة 100% البسلة بنسبة 50% من معدل التقاوى الموصى بة وكذلك العلاقات التنافسية وصافى العائد . نفذت التجربة فى تصميم القطع المنشقة فى ثلاث مكررات. تم تخصيص القطع الرئيسية لأصناف القمح (جميزة11،جيزة 171 ،مصر 1) بينما تم تخصيص القطع الشقية لمستويات السماد النيتروجيني (75،60،45 كجم نتروجين / فدان) تفوق الصنف مصر1 معنوياً على أصناف القمح الأخرى المدروسة في المحصول ومكوناتة للقمح المحمل مع البسلة، يلية الصنف جيزة171 ثم الصنف جميزة 11 في كلا الموسمين. نتجت أعلى القيم لصفات النمو والمحصول ومكوناته للبسلة عند التحميل على القمح صنف جميزة 11، يليه تحميل البسلة مع القمح صنف جيزة171 ثم التحميل مع القمح صنف مصر1 في كلا الموسمين. أدى إضافة 75 كجم نتروجين / فدان إلى زيادة معنوية في جميع الصفات المدروسة لكل من القمح والبسلة المحملين معا ، يليه التسميد بـ 60 كجم نتروجين / فدان ثم التسميد بـ 45 كجم نتروجين / فدان في كلا الموسمين.

من النتائج المتحصل عليها فى هذه الدراسة فانة يمكن استنتاج أنه عند تحميل االبسلة بنسبة 50 % مع القمح بنسبة 100 % لكل منهم أعطى أعلا معامل لإستغلال الأرض (LER) وإجمالي الدخل وصافى العائد النقدى لكل من القمح والبسلة والذى نتج من تسميد صنف القمح مصر1 بـ 75 كجم نيتروجين / فدان تحت الظروف البيئية لمحافظة كفر الشيخ ، مصر. فى كلا الموسمين.